EMERGENCY RESPONSE TO NATURAL GAS VEHICLES

PROGRAM GOALS

To provide the emergency responder with information about natural gas vehicles so that they can make informed decisions at the scene of an emergency.

This information should be correlated with your departments Standard Operating Guidelines for incident management, scene safety, auto extrication and rescue.

STUDENT INTRODUCTIONS

What's your name?

What's the name of your organization?

What's your interest in natural gas vehicles?

Have you ever fought a natural gas fire?

Main Menu

- INTRODUCTION
- VEHICLE IDENTIFICATION
- PROPERTIES OF CNG & LNG
- CYLINDERS - TANKS - REFUELING
- EMERGENCY RESPONSE

EXIT

Objective

INTRODUCTION

Cite why natural gas is a popular alternative fuel.

Determine how natural gas vehicles will impact emergency response.

INTRODUCTION TO NGV'S

WHY NATURAL GAS?

Solves environmental problems- non-toxic and non-corrosive, natural gas does not contribute to air, soil or water contamination

Meets low emission standards & mandates established by the Government

Reduces our reliance on foreign oil- vast reserves of natural gas are available in the U.S.

INTRODUCTION TO NGV'S

NATURAL GAS ADVANTAGES

Natural gas is available in a rapidly expanding retail infrastructure

California has over 80,000 miles of distribution pipeline

There are 127 public access refueling stations in California

INTRODUCTION TO NGV'S

NATURAL GAS ADVANTAGES

Over 1,500 refueling facilities across the U.S.

Which service over 109,000 NGV's in the U.S. with another 1,000 being sold annually

INTRODUCTION TO NGV'S

NATURAL GAS ADVANTAGES

Over 40 different manufacturers are producing light, medium and heavy duty natural gas vehicles

Driving cost and range for CNG vehicles is comparable to gasoline and diesel engines

Operating and maintenance costs are lower than conventional vehicles

INTRODUCTION TO NGV'S

NATURAL GAS ADVANTAGES

Lower driving and operating costs makes NGV's a popular fleet vehicle

INTRODUCTION TO NGV'S

NATURAL GAS ADVANTAGES

Natural gas is lighter than air and will not pool on the ground like gasoline, diesel or propane vapors

Fuel storage containers are stronger than gasoline tanks

Two unique storage techniques; compressed or liquefied natural gas (CNG) (LNG)

INTRODUCTION TO NGV'S

IMPACT ON EMERGENCY SERVICES

There were 511,248 traffic collisions on California roads in 2000

Of these 3,331 were fatal and 198,348 were injury related

With more and more natural gas vehicles entering the highways, the potential for natural gas vehicle emergencies will grow

Summary

As one of many alternative fuel choices, natural gas makes sense for a variety of reasons.

The question is- how will this technology affect your response to vehicle emergencies?

Your understanding of natural gas and NGV technology will provide the answer.

Objective

VEHICLE IDENTIFICATION

Identify the differences and similarities between natural gas vehicles and other vehicle fuel types.

Perform vehicle shutdown procedures.

VEHICLE IDENTIFICATION

NGV TYPES

Light Duty
Ford, GMC, Chevy and Honda

Medium and Heavy Duty
Blue Bird, Isuzu, Freightliner and Mack

Engine Makers
Caterpillar, Detroit Diesel, Cummins and John Deere

VEHICLE IDENTIFICATION

NGV TYPES

Some vehicles are bi-fuel, operating with both gasoline and natural gas

Emergency response must include an identification of fuel types before emergency operations begin

VEHICLE IDENTIFICATION

HOW CAN YOU TELL?

NGV's are modified from the same make and model of vehicles on the road

When an NGV is delivered to a customer it comes equipped with a distinctive diamond shaped insignia with CNG or LNG printed in the middle

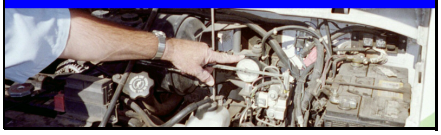
VEHICLE IDENTIFICATION

HOW CAN YOU TELL?

VEHICLE IDENTIFICATION

VEHICLE OPERATION

An ignition key is used to turn the engine, allowing the fuel to flow from the CNG cylinder or LNG tank to the pressure regulator, then to the internal combustion engine



VEHICLE IDENTIFICATION

THE FUEL REGULATOR

On CNGV's the fuel regulator reduces the pressure from 3,600 psi to a range of 60 to 120 psi

On LNGV's the fuel is regulated from 230 psi to a range of 75 to 120 psi

The fuel regulator is usually found in the engine compartment

VEHICLE IDENTIFICATION

FUEL SYSTEM

Fuel flows from the cylinder or tank through stainless steel tubes and high pressure fittings to the regulator and from the regulator to the engine

On LNG vehicles the fuel will flow through a heat exchanger to warm and expand the gas vapor before it flows to the engine compartment

VEHICLE IDENTIFICATION

EMERGENCY RESPONSE

There is no case where the high pressure fuel lines transverse the posts, roof, or passenger compartment of the vehicle

Realizing that high pressure fuel lines are present- care must be exercised in extrication emergencies so that fuel lines are not inadvertently severed

VEHICLE IDENTIFICATION

VEHICLE SHUTDOWN

To shut-down an NGV, turn the ignition key to the off position, this will shut-down the engine and simultaneously stop the flow of fuel from the fuel cylinder

To ensure that the natural gas is no longer flowing fuel or to stop a fuel leak in the system- locate the shut-off valve under the vehicle chassis or close to the fuel cylinder or tank and turn the knob

Summary

Natural gas vehicles use the same internal combustion engine technology that we are familiar and comfortable with. The only difference is in the type of fuel that is being carried and used.

Objective

Properties of Natural Gas

Cite the properties of natural gas.

Assess the danger in a natural gas leak.

Develop mitigation measures for a natural gas leak.

NATURAL GAS

CHARACTERISTICS OF CNG

Natural gas is compressed so that it can be used as a practical and portable fuel supply

Compressed Natural Gas is mostly methane with 15% to 20% of other gases like ethane, propane and butane

Methane is the simplest hydrocarbon made from four hydrogen and one carbon atom

NATURAL GAS

CHARACTERISTICS OF CNG

Natural gas is lighter than air and naturally colorless and odorless

To aid in detection, mercaptan is added for smell which can be detected long before the gas reaches its lower flammability limits

Natural gas is non-toxic and presents no exposure hazards, but can displace oxygen in confined areas

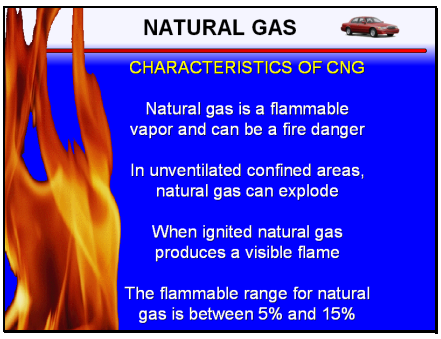
NATURAL GAS

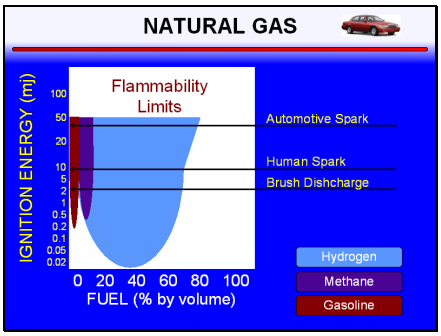
CHARACTERISTICS OF CNG

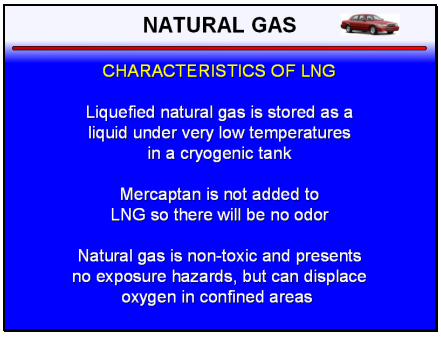
CNG is stored under high pressure, if a system fails, gas can be suddenly and forcefully released

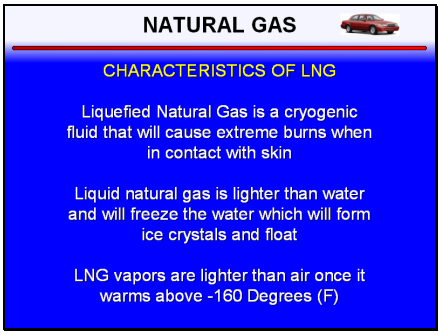
CNG systems are commonly pressurized to 3600 psi

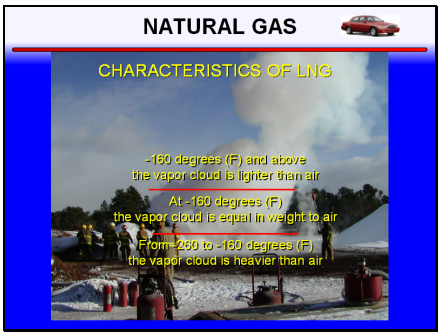
Natural gas is lighter than air and will rise when released to the atmosphere


NATURAL GAS
CHARACTERISTICS OF CNG
Natural gas is a flammable vapor and can be a fire danger
In unventilated confined areas, natural gas can explode
When ignited natural gas produces a visible flame
The flammable range for natural gas is between 5% and 15%


NATURAL GAS
IGNITION ENERGY (mj)
100
50
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
Flammability Limits
Automotive Spark
Human Spark
Brush Dishcharge
0 20 40 60 80 100
FUEL (% by volume)
Hydrogen
Methane
Gasoline


NATURAL GAS
CHARACTERISTICS OF LNG
Liquefied natural gas is stored as a liquid under very low temperatures in a cryogenic tank
Mercaptan is not added to LNG so there will be no odor
Natural gas is non-toxic and presents no exposure hazards, but can displace oxygen in confined areas


NATURAL GAS
CHARACTERISTICS OF LNG
Liquefied Natural Gas is a cryogenic fluid that will cause extreme burns when in contact with skin
Liquid natural gas is lighter than water and will freeze the water which will form ice crystals and float
LNG vapors are lighter than air once it warms above -160 Degrees (F)


NATURAL GAS
CHARACTERISTICS OF LNG
-160 degrees (F) and above
the vapor cloud is lighter than air
At -160 degrees (F)
the vapor cloud is equal in weight to air
From -260 to -160 degrees (F)
the vapor cloud is heavier than air

NATURAL GAS

CHARACTERISTICS OF LNG

Gas when cooled becomes a liquid:

Steam turns to water at 212 degrees

Methane turns to liquid at -258 degrees

This is equivalent to compressing natural gas to 9,300 psi

NATURAL GAS

THE ADVANTAGES OF LNG

LNG lowers the percentage of impurities providing a consistent and controlled gas to air mix for combustion

Lower storage pressure, 230 psi for LNG compared to 3,600 psi for CNG

An LNG tanks have greater storage density than CNG- storing 2-3 times as much gas as a CNG cylinder

NATURAL GAS

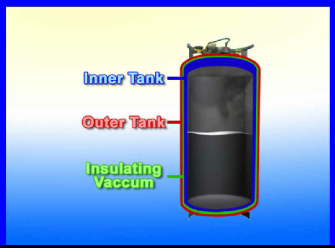
LIQUEFIED NATURAL GAS

LNG is stored, thermos like, in double walled stainless steel tanks with a vacuum and insulating blanket between the walls

Should both walls of the container fail, fuel can leak out, pool on the ground, and form a vapor cloud that will quickly dissipate into the atmosphere

NATURAL GAS

LIQUEFIED NATURAL GAS TANK



NATURAL GAS

LIQUEFIED NATURAL GAS

BLEVE's or other catastrophic failures have never been a reported for an LNG storage tank

The physical differences between Liquefied Natural Gas (LNG) and Liquefied Petroleum Gas (LPG), along with the different storage techniques, BLEVE's are less of a concern for LNG tanks

NATURAL GAS

LIQUEFIED NATURAL GAS

Water should not be sprayed on an LNG fuel spill

Water will warm the liquefied gas rapidly causing a faster release of vapor

The cryogenic liquid should not be allowed to flow into storm or sewer drains, but instead contained with a berm of dirt or sand

Summary

In this section you learned that natural gas, while flammable, is as safe as diesel or gasoline fuels.

Though precautions are in order, no more so than when dealing with all types of vehicles incidents.

Objective

REFUELING

Recognize cylinder safety features and deficiencies.

Pre-Plan NGV facilities.

Identify fuel shut-off valves and locations.

REFUELING

CNG CYLINDERS

CNG cylinders are similar in design and construction to self-contained breathing apparatus

The cylinder is rated for service at 3,600 psi but will withstand pressure in excess of 8,100 psi

Cylinders should never be pressurized above their maximum fill pressure

Life span of a CNG cylinder is 15 - 20 years

REFUELING

CNG CYLINDER TYPES

Type I - All metal, steel or aluminum

Type II - Metal liner and hoop wrapped

Type III - Thin metal liner, fully wound overwrap

Type IV - Plastic liner, fully wound overwrap

REFUELING

CYLINDER SENSITIVITY

Cylinders are susceptible to environmental damage

Steel- corrosion on exposed surfaces

Aluminum- galvanic corrosion when in contact with other metals

Composite- sensitive to abrasions, cuts, impact and strong acids

REFUELING

CYLINDER STANDARDS

NGV2
"Basic Requirements for Compressed Natural Gas Vehicle Fuel Containers"

This standard contains ten design qualification tests including; pressure cycle, environmental pressure, burst, impact, and bonfire tests

REFUELING

CYLINDER STANDARDS

FMVSS 304
(49 CFR 571.304)
"Compressed Natural Gas Fuel Container Integrity"

This mandatory standard is applicable to all CNG cylinders sold for motor vehicle use

REFUELING

CYLINDER STANDARDS

NFPA 52
"Compressed Natural Gas Vehicles"

This standard ensures that pressurized CNG cylinders are protected from damage by road hazards and mounted to minimize damage from collisions:

REFUELING

NFPA 52
"Compressed Natural Gas Vehicles"

Fuel cylinders cannot be mounted in front of or behind vehicle axles

Cylinders must be securely fastened

Pressure relief devices must be vented to the outside of the vehicle and release gas when exposed to fire before the cylinder ruptures

REFUELING

CNG REFUELING

Pipelines deliver natural gas to the refueling center

Distribution feeder lines deliver gas at or below 60 psi

Transmission lines delivers gas at 60 psi or greater

REFUELING

CNG REFUELING

Natural gas is processed in several stages:

1. Dryers - remove moisture

2. Filters- remove particulates

REFUELING

CNG REFUELING

3. Compressors- compress gas to 3,600 psi

4. Storage Tanks- can hold 10,000 cubic feet or 100 gallons/cubic feet of product

REFUELING

CNG REFUELING

To improve safety NFPA 52 specifies fuel shut-offs:

Manual shutoff at the dispenser

Break away protection

Emergency shut-off remotely located from the dispenser

Curbside shut-off

REFUELING

FACILITY PRE-PLANNING

Review MSDS Sheets and Emergency Action Plan

Preplans should include:
Location of fuel storage areas
Manual and emergency shut-offs
Proximity to exposures
Fire Department access and water supply

REFUELING

RESIDENTIAL REFUELING

Residential refueling allows for vehicle owners to tap in to the natural gas delivered to their homes to refuel their vehicles

Refueling system safeguards are outlined in NFPA 52 and are designed to minimize the possibility of physical damage and vandalism

REFUELING

LNG TANKS & REFUELING

NFPA 57
"Liquefied Natural Gas
Vehicular Refueling Systems"

Tanker trucks to deliver LNG to refueling centers

A tanker can hold up to 10,000 gallons of LNG

It is estimated that 200,000 gallons of LNG are trucked into California every day

REFUELING

Pit fire on the south rim of the Grand Canyon.

REFUELING

LNG TANKS & REFUELING

The delivery truck transfer LNG to an on-site storage tank or another vehicle for mobile refueling

Refueling operators wear rubber aprons, work boots, leather welding gloves, safety glasses and face shield to protect themselves from the cryogenic liquid

REFUELING

LNG TANKS & REFUELING

Fuel is transferred from the storage tank to the vehicle through a dispenser

REFUELING

LNG TANKS & REFUELING

Emergency shut-off switch is located at the dispenser and another within 50 feet

REFUELING

LNG TANKS & REFUELING

To keep the liquid from reaching its boiling point cryogenic tanks consists of 2 nested tanks that form a thermos-like insulating vessel

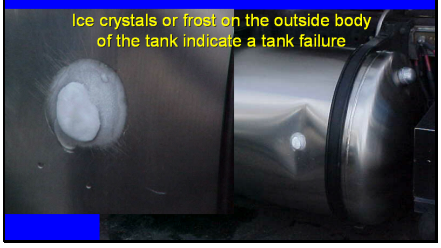
Ice crystals or frost on the outside body of the tank would indicate tank failure

A "sweaty" tank indicates a loss of vacuum pressure between the tanks

REFUELING

LNG TANKS & REFUELING

Ice crystals or frost on the outside body of the tank indicate a tank failure



REFUELING

LNG TANKS & REFUELING

Ice crystals and frost around the valve stem are normal

REFUELING

CNG CYLINDERS & LNG TANK LOCATION

Cylinder and tank location is dependent on the vehicle model and manufacturer

Fuel storage can be found in the rear, trunk, pick-up bed, as side tanks, or on top of the vehicle

Summary

This section provided you with information about the relative safety of natural gas cylinders and tanks along with the safety features required for refueling stations. From here we can begin to develop emergency response procedures.

Objective

EMERGENCY RESPONSE

Recall specific safety guidelines for natural gas emergencies.

Develop a Standard Operating Guideline for your department.

Make informed decisions at the scene of an NGV emergency.

EMERGENCY RESPONSE

GUIDELINES

Personnel are required to wear full structural fire fighting clothing as well as SCBA

Deploy a charged hose or handline when approaching a vehicle emergency

Avoid cutting around fuel lines or fuel storage areas of the vehicle

Isolate the fuel with the manual shut-off valve

EMERGENCY RESPONSE

CNG HAZARDS TO EMERGENCY PERSONNEL

A CNG leak could produce a high velocity cold gas jet

Injuries can be sustained from flying debris, the high jet momentum, or exposure to extremely cold gas near the release point

When the gas diffuses, reaching its flammable range and finds an ignition source, a jet fire or torch fire could result

EMERGENCY RESPONSE

CNG HAZARDS TO EMERGENCY PERSONNEL

The greatest danger of natural gas leaks is in confined spaces where it can displace the oxygen in the atmosphere and become an asphyxiant hazard

In confined spaces, and in the proper flammable range, natural gas can more likely find a source of ignition and explode

EMERGENCY RESPONSE

CNG HAZARDS TO EMERGENCY PERSONNEL

CNG MAINTENANCE FACILITY

EMERGENCY RESPONSE

EFFECTIVE RESPONSE TO CNG

EMERGENCY RESPONSE

EFFECTIVE RESPONSE TO CNG

Isolate potential sources of ignition from coming into contact with the fuel leak

Turn off the gas at the source or,

If the plume is on fire, protect surrounding exposures and allow the gas to burn itself off

EMERGENCY RESPONSE

EFFECTIVE RESPONSE TO CNG

With vehicle fires water and/or foam can be used to put out the interior of a vehicle

If the gas vents from the pressure release device and is on fire let it burn itself out

Protect exposures with water and/or foam

EMERGENCY RESPONSE

EFFECTIVE RESPONSE TO CNG

CNG is always odorized, you should be able to detect a leak before the gas reaches its flammable limits

LNG is generally odorless, use a gas detector to identify leaks

You cannot rely on the characteristic smell to detect an LNG leak

EMERGENCY RESPONSE

LNG HAZARDS TO EMERGENCY PERSONNEL

LNG is a cryogenic liquid that can cause first degree burns when in contact with exposed skin

LNG reacts violently when water is applied, the reaction warms the liquid to boiling creating more gas vapor

Adding water to an LNG liquid fire will intensify the fire

EMERGENCY RESPONSE

EFFECTIVE RESPONSE TO LNG

EMERGENCY RESPONSE

EFFECTIVE RESPONSE TO LNG

It is best to allow the LNG fuel spill to vaporize and disperse into the atmosphere

EMERGENCY RESPONSE

EFFECTIVE RESPONSE TO LNG

Large spills would require evacuating the area within a 1,000 foot perimeter

Use hose streams to direct the vapor cloud away from buildings and other potential sources of ignition

EMERGENCY RESPONSE

EFFECTIVE RESPONSE TO LNG

FIRE CONTROL

Use dry powder or Purple K, to extinguish

Use high expansion foam on liquid spill fire to reduce the intensity of the fire

EMERGENCY RESPONSE

EFFECTIVE RESPONSE TO LNG

Whenever possible isolate the LNG fuel leak from the source

Use dirt or sand to build a berm around an LNG fuel leak

Make every attempt to keep the liquid from entering storm and sewer drains or from entering enclosed spaces

EMERGENCY RESPONSE

EFFECTIVE RESPONSE TO LNG

EMERGENCY MEDICAL

LNG will cause first degree burns and frostbite if not treated immediately

If a person has LNG on their clothes be sure to immediately defrost the fabric with water before trying to remove the clothing

Additional skin damaged could result if the frozen clothing is removed before being defrosted

EMERGENCY RESPONSE

TYPES OF NGV EMERGENCIES

Emergencies involving NGV's can occur

in vehicle accidents,

during refueling operations,

as a result of maintenance

EMERGENCY RESPONSE

YOUR EMERGENCY RESPONSE TO NGV'S

Your response maybe dictated by your departments Standard Operating Guidelines and your own experiences

How will the information you learned today alter your response in the future?

Summary

By understanding the basic characteristics of natural gas and NGV fuel technology you can extrapolate ways to respond to a variety of vehicle incidents.